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**Abstract**

# AN ANALYTICAL METHOD FOR NEUTRON THERMALIZATION CALCULATIONS IN HETEROGENEOUS REACTORS

by

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It is well known that the use of diffusion approximation for studying neutron thermalization in heterogeneous reactors may lead to considerable errors. On the other hand, exact non-diffusional methods, which are numerical and rather laborious, require the use of large digital computers. In this paper the use of diffusion approximation in absorbing media has been avoided but the treatment remained analytical. This made possible a clearer insight into the physics of the phenomenon and a simpler way of practical calculations.

The moderator is treated according to the heavy gas model, the slowing down in the fuel is neglected, and the angular distribution of neutrons at the fuel boundary is assumed to be isotropic. The non-Maxwellian factor of distribution in the moderator is expressed as a sum of an exact one-velocity solution and a series of Laguerre polynomials multiplied by Bessel functions. An energy dependent boundary condition on the fuel surface has been determined by the neutron balance method without the use of diffusion approximation and the resulting formula has been connected with corresponding escape probabilities whose energy dependence is determined from basic cross-section data. The effects of using different escape probabilities have been studied. Explicit formulae for calculating disadvantage factors of the fuel and the moderator, the mean neutron energy and the neutron temperature, have been derived. The convergency of the expansions has shown to be satisfactory. The method has been adapted for practical calculations with different temperatures and different cylindrical fuel elements including claddings.

To check the method, heavy water and graphite cells were calculated by using both the diffusional and the more exact methods with and without taking thermalization into account. The results of the proposed method have shown to be considerably more accurate than the diffusional ones and they are in good agreement with Honeck's numerical and experimental results. Finally, the method has been used for theoretical analysis of experiments on the Yugoslav RB reactor.